REPORT OF THE SCIENCE PRIORITIES BREAKOUT GROUP

LCLUC Second Science Team Meeting
Warrenton, Virginia
30 March - 1 April 1998

C.A. Wessman & B. L. Turner II

Premise:

The global environmental change community, from science to policy, is expanding from a primary focus on global warming to a broader environmental agenda captured in the "sustainability transition". The central question of this transition, as articulated by the NRC's Board on Sustainability, is: "How do we provide employment and improved standards of living for a world of 10 billion without threatening the earth's life support system?" The support system is the biosphere and its critical resources. Thus the environmental problem is expanded to the structure and functioning of the biosphere, including climate warming, to critical resources for humanity, from biotic diversity to water quality.

Role of NASA's Land-Cover and Land-Use Change program:

Study of changes in land cover and land use are pivotal to the sustainability transition because the terrestrial biomes of earth provide the essential food, water, and mineral resources on which the 10 billion will exist. The transformations of these biomes are unprecedented in human history - in magnitude, spatial scale, and pace. The sustainability transition focuses on the implications of this transformation for a warmer, wetter, more crowded, stressed, and demanding world, requiring improved understanding of them in order to reduce threats to our life support systems.

NASA's participation in science at the human-ecosystem interface is critical for the advancement of interdisciplinary collaborations. NASA has been important to "big science" and can uniquely contribute to the data requirements needed for these syntheses. Temporal and spatial measurements of landscape and regional heterogeneity are fundamental to understanding land-cover/land-use change trajectories and implications for sustainability. New and upcoming quantitative capabilities in remote sensing, stand-alone and coupled with ecosystem simulation models, can better define environmental constraints on land use and cover change. Similarly, patterns and rates of land-cover change can strengthen understanding of social and economic controls.

General and Specific Issues Requiring Special Attention:

The sustainability transition opens LCLUC to a plethora of unresolved questions, both substantive and methodological, that are linked to but go beyond that of the carbon cycle in a global warming vision of LCLUC. All of these questions, however, are anchored on two basic themes: (i) how do changes in land use affect the dynamics of land cover properties (e.g., biomass, productivity, soil nutrients, hydrologic cycle); and (ii) how do changes in land

cover and associated biophysical/biogeochemical processes affect land use. The focus of LCLUC, then, is on the land-use/land-cover change interface with terrestrial ecosystem dynamics, with underlying forcing from climate variability and atmospheric compositional change (Figure 1). Understanding these questions, of course, requires improved understanding of the explanatory dynamics of use and cover change as well as of the means of modeling these dynamics.

The two general questions of this research are:

1. What are the relative roles of biophysical, biogeochemical, and anthropogenic drivers of LCLUC, and their temporal and spatial variability?

2. How can explanatory and integrated models of LCLUC be improved that incorporate the scalar capacity to link the local, regional, and global?

Specific questions are:

1. At what scales do biophysical, biogeochemical and human processes most closely overlap and match one another, and are these scales the optimal entries for LCLUC understanding?

2. How can complexity, uncertainty, surprise, and path dependency be used to improve LCLUC understanding and vice versa?

3. How can LCLUC be used to refine the concept of vulnerability and identify vulnerable ecosystems, peoples, and human-environment relationships?

4. How can LCLUC be used to address mitigation and adaptation strategies?

These questions, issues, and themes raise a number of points about sensors and data which NASA should seriously consider.

A. Spatially explicit information and observations of the roles and impacts of human agency and social structures are desperately needed.

B. Land-cover and land-use change histories require documentation.

C. Quantification of biophysical and biogeochemical interactions and feedbacks on land cover and land-use at landscape and regional scales is required.

D. Continuity and increased frequency in measurements of landscape structural and functional change are absolutely critical. (This not only applies to current measurements, but to improved metrics evolving from algorithm development and improved instrumentation.)

Figure 1. Regional impacts of climate variability, atmospheric composition change, and socioeconomic factors are integrated within the landscape through land cover (i.e. vegetation type and distribution) and the management strategies employed to maintain, manipulate, or convert that cover (i.e. land use). Ecosystem sustainability will be determined by immediate and longer-term biogeochemical and biophysical processes and their feedbacks on climate and land-use systems.